Space Weather Technical Forecast

Issued on Friday, 13 October 2023 at 13:02 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES16 and 18 has greatly reduced in the past 24 hours, with few well-defined flares and with the X-ray background reducing from mid C-class to high B-class. The peak flare of the period was a C3.0 from AR3464 at 12/1232UTC, although this was essentially unremarkable against the similar background.

There are now up to six sunspot regions on the facing side of the Sun, although another SDO HMI imagery outage as of 13/0445UTC is again hampering analyses (although it was restored at the time of issue of this document). This is perhaps especially relevant for diagnosing the arriving eastern solar horizon, where numerous returning regions are anticipated. NSO GONG imagery trends suggest the main tendencies have been for spreading and fading of intermediate spots in some of the larger groups on the disc, namely AR3464, 3463 and 3460. The period of HMI availability preceding 13/0445UTC also revealed that the previous Mt Wilson delta spot had faded from the trailer of AR3460, with all spots now either simple east-west dipoles, else being unipolar.

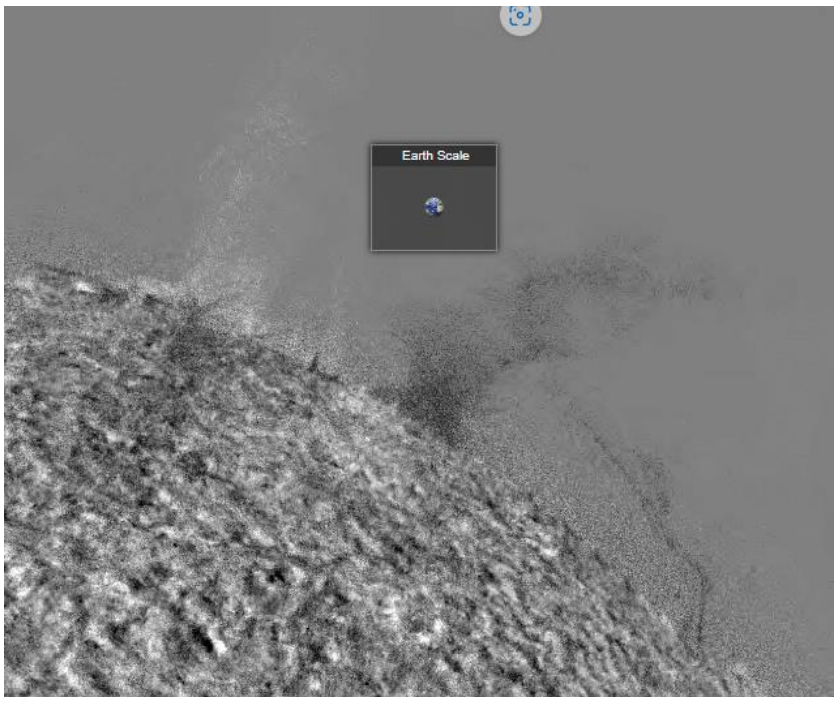

Figure 0: Helioviewer.org-derived AIA304 2-hour integrated difference imagery ending 12/1800UTC. This shows the semi-circumpolar filament lift off in the western hemisphere during the late UTC afternoon of 12 October. The ejecta may have bifurcated, with the white portion being directed towards Earth but above and ahead of the track of its orbit. Earth shown for scale.

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The C9.7 flare from AR3460 near centre-disc in the preceding 24-hour period produced no Coronal Mass Ejection (CME) despite an accompanying dimming. The current reporting period showed a large high latitude western solar hemisphere filament lift off through much of the UTC afternoon. This resulted in a large CME becoming visible into the past UTC overnight period. This has been analysed as a miss above and ahead of the track of the Earth's orbit. Other events in the period included a minor narrow CME from the vicinity of AR3454 on the western limb, which has again been analysed and is expected to pass well ahead of the Earth to no effect.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1 started in a slow regime but showed a very marked progression into a CIR, developing in earnest from around 13/0300UTC. This is most likely to be the substantially delayed fast wind emanating from trans-equatorial CH58/-. There has been a concurrent rise across the low energy proton spectra at ACE EPAM LEMS.

The solar wind speed rose from 300 to 375km/s in the period, with much of this occurring after 13/0300UTC. The associated solar wind density change was more marked still, rising from single-figures ppcc to the low-thirties with the CIR. The IMF showed a similarly increasing magnitude signal, rising from a stable Background to peak at 24nT after 13/0800UTC, although the north-south component was fortunately almost purely co-aligned with Earth's field, meaning the +22nT peak was not matched by an anti-aligned value, which only reached -9nT. The phi angle was mainly negative (towards the Sun), but showed occasional deflections into positive territory.

The net effect of the above solar wind measures was initially Quiet geomagnetic activity, but rising to Unsettled in the current UTC morning, with a provisional Kp peak of 3o in the 06-09UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at Background levels.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels, peaking around 250pfu at 12/1800UTC. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 13/0001UTC was 5.48e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a slightly rising Chance of M-class flares through the four-day period as a result of eastern limb arrivals into the UTC weekend.

Solar Wind / Geomagnetic Activity: No CMEs feature in the current forecast.

The current CIR is likely to lead into the overdue fast wind from CH58/-. Its character remains to be seen, however tentatively there is a restored Chance of G1 in the first 24 hours, probably becoming mainly Quiet again as the UTC weekend progresses. By the new working week CH60's fast wind may arrive, again leading to a Chance of further G1.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux will most likely remain at Background levels.

Thoughts surrounding the high energy electron flux (greater than 2MeV) forecast are now in a state of flux themselves as the character of the imminent fast wind (probably from CH58/-) remains to be seen. There is a tentatively restored Chance of Active 24-hour fluence from later

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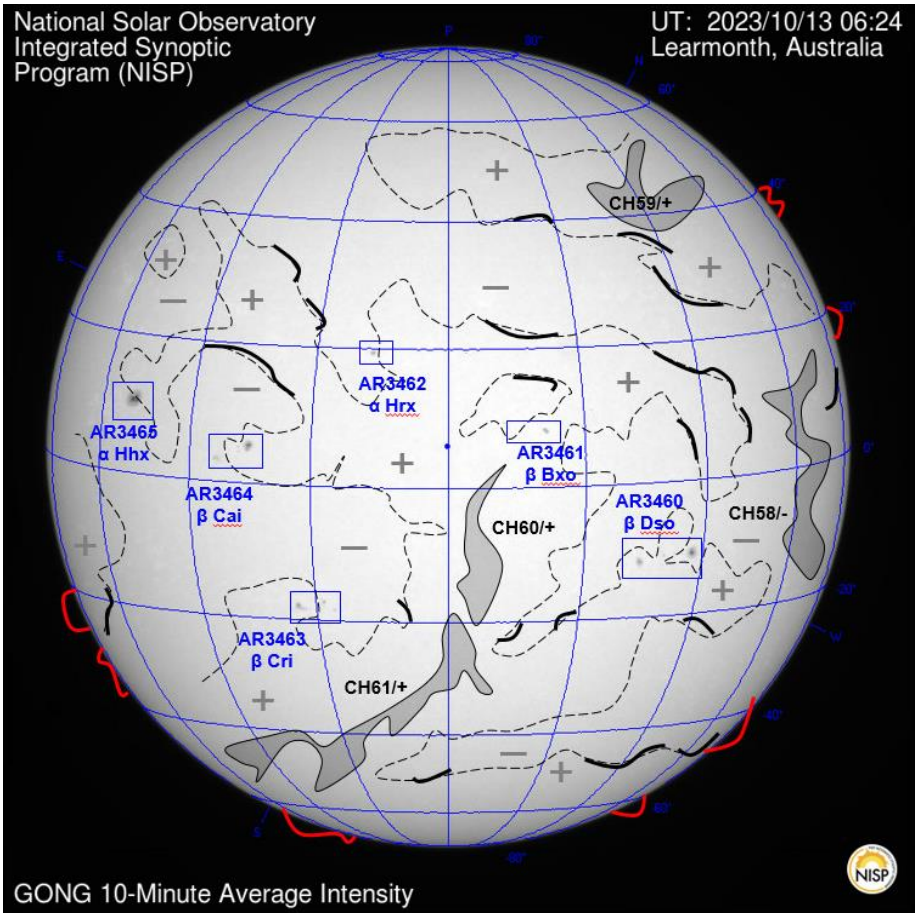
in the UTC weekend, although this forecast is subject to revision.

Figure 1. Solar Analysis Valid 13/0625UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

No CMEs feature in the forecast.

The currently observed CIR at L1 is unusually strong, and is perhaps most likely to be the forerunner of the overdue CH58/-, given the latter's position on the disc in being trans-equatorial. The reason for its tardiness is uncertain, but it either implies a lower emanating solar wind speed (of around 400km/s - versus the 600km/s anticipated), or the emanating solar wind is not purely radial - instead being angled slightly westward (super-radial). The latter hypothesis is perhaps more likely given the magnitude of the CIR, although this remains to be seen. As a result of the current CIR, the Chance of G1 has been restored in the current UTC day, waning into the UTC weekend as previously forecast given the (by this point) maturing fast wind.

There then should follow a lull later in the UTC weekend and perhaps into the new working week, ahead of a positive polarity coronal hole feature rounding out the forecast in the form of CH60/+. Because of the time of year, this second fast wind may prove to represent the peak of activity for the four days as a whole, although the forecast is perhaps best summarised as twin peaks of a Chance of G1, separated by a Quieter lull.

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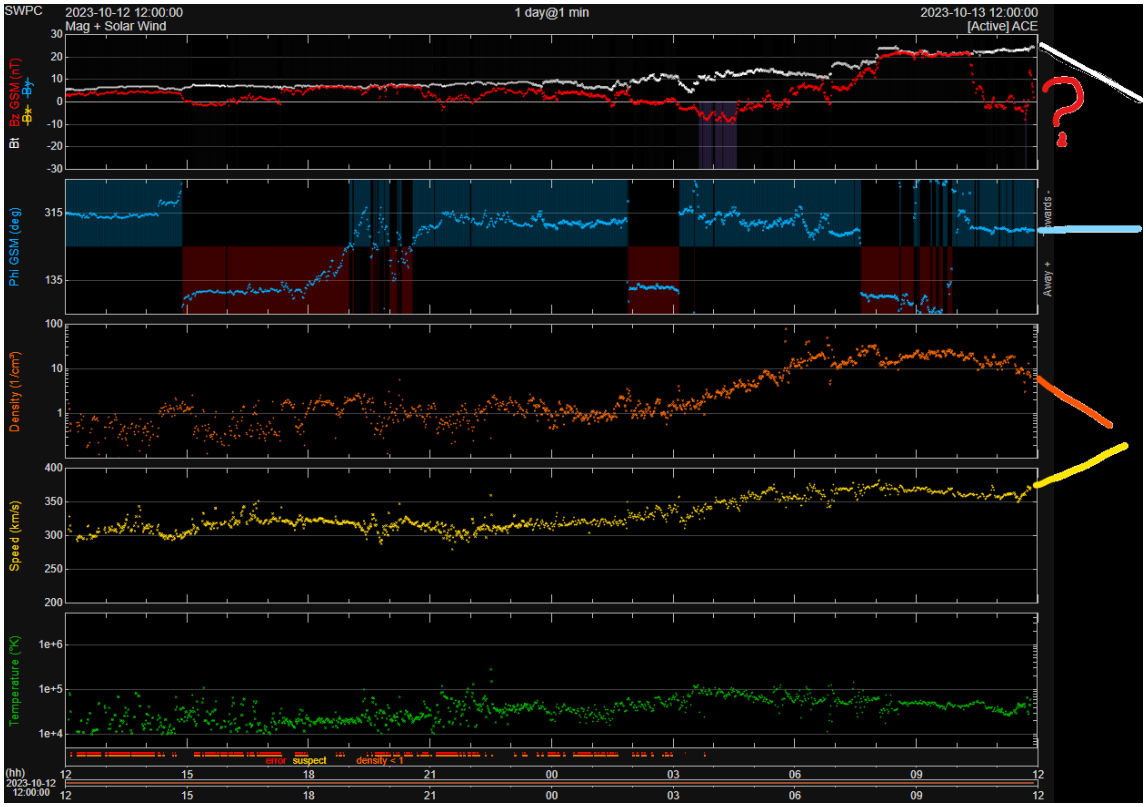
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	25	5	1	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: NOAA SWPC visualization of the past 24 hours in L1 solar wind measures from DSCOVR, showing the onset and development of a marked CIR. Expected trends are annotated onto the RHS of the plot - the density should shortly drop as the coronal hole proper takes hold, with the Chance of G1 restored in the event that the Bz component falls any further.



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Radio Blackouts - X-Ray Flares:

An HMI imagery outage is again hampering analyses of sunspot groups, particularly the arriving eastern solar horizon, which is anticipated to harbour several returning regions from due Carrington longitudes and from far-side sounding evidence. In particular, the lack of a flattened high resolution intensitygram is missed.

NSO GONG imagery loops of current sunspots imply a generally simplifying trend, with this also inferred from the quietening X-ray trace at GOES 16 and 18, and the Penticton 10.7cm flux drop from 166sfu on 10 October to the most recent observation of 157.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	30	40	40	40
Very Active	R3 to R5 X Class	No	1	5	5	5

Figure 3: Past 24 hours in PROBA2 C-class flares and above, as produced by SIDC ROB. Note that the main contributions were early in the 24 hours and on the western limb, with the departure of Ex-AR3451 and imminent departure of AR3454 providing part of the rationale for the initial lowered flare risk, with the eastern limb likely to reverse this as the four-day period progresses.

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at Background levels.

There remains a Slight Chance of S1/Minor Solar Radiation Storms throughout the period, should any suitable larger flares occur.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron forecast is now of lowered confidence given the belated arrival of a marked CIR, and the resulting dissimilarity between the current conditions and persistence. Initial Normal Background to Moderate diurnal variation is likely to show some attenuation at first, probably rebounding at GEO later in the UTC weekend, with perhaps a restored Chance of surpassing Active should the fast wind be emitted nearer the expected 600km/s rather than the purely radial assumption of 400km/s. The very end of the four day period should again see reducing counts at GEO in terms of electrons, however the exceedence risk still applies for earlier in that UTC day.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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